

DiMES and PFC relevant experiments from DIII-D

1. DiMES sample and hard wares
2. VDE disruption shot #114667
 - Equilibrium and parameters
 - Surface temperature distribution
 - Particle flux distribution
 - Tile currents
 - Erosion of graphite DiMES
3. C¹³ co-deposition experiment
4. He discharges on physical and chemical sputtering

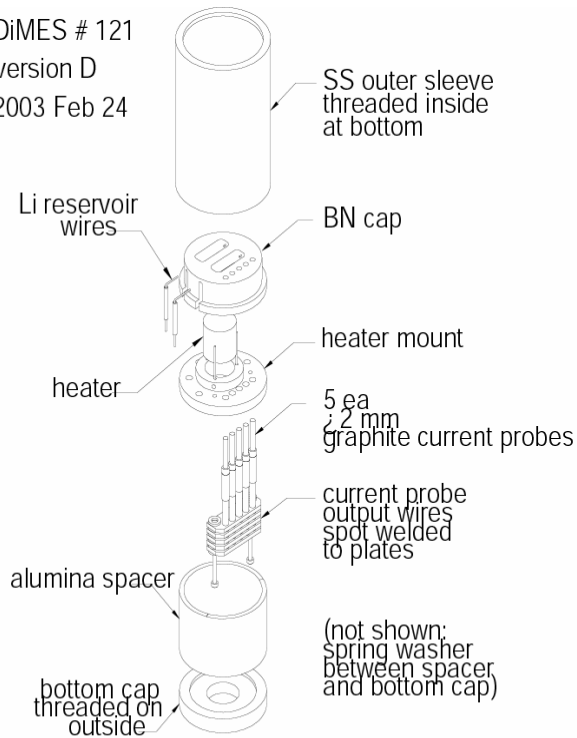
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J. Watkins, R. Bastasz, J. Whaley, W. Wampler (SNL) S. Allen, C. Lasnier (LLNL)
D. Whyte (UW) P. Stangeby, A. McLean (U of Toronto) R. C. Isler (ORNL)



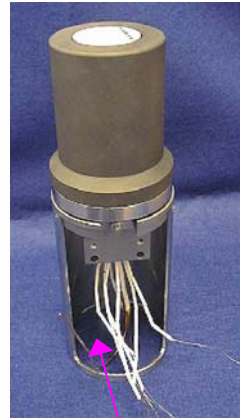
US PFC Meeting, Nov. 17-20, 2003, Oakbrook, IL.

Li-DiMES and additional hard wares

DiMES # 121
version D
2003 Feb 24



Note:
In order to have 5 current probes, 2 wires in each Li reservoir, heater, and thermocouple all on independent circuits, the shield wire must be used as a current carrying conductor.



**Li-DiMES
w/o Li-slots**



DiMES rack with power supply



DiMES internal cables terminal

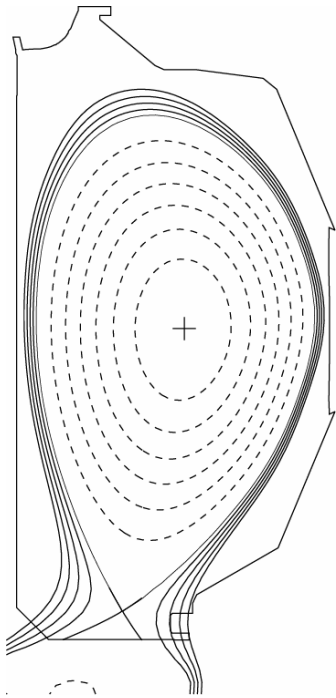
5 channels of optically coupled isolated amplifiers are in order.

Disruption in DIII-D to simulate ITER ELMs DiMES exposure to shot # 114667

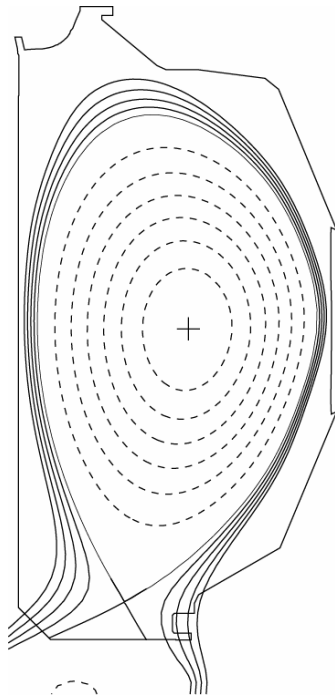
- ITER FEAT ELMs¹: 0.5-2 Hz, $\Delta W_{th}/W_{th} \sim 2-6\%$, implies 1.2 to 3.6 MJ, when $W_{th}=60$ MJ, deposition time 0.1-1 ms.
- DIII-D VDE disruption: Total energy release 0.5 to 2 MJ (thermal+magnetic+conduction+radiation+auxiliary) dissipated in a 2-3 ms.

The goal is to provide disruption data from DIII-D and corresponding DiMES material surface erosion/damage to bench mark ITER ELMs modeling.

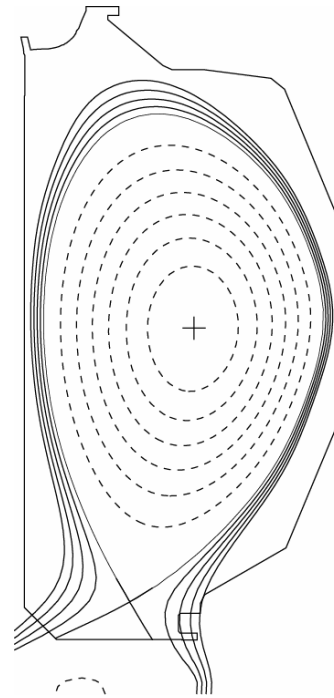
DIII-D VDE Displacement shot # 114667



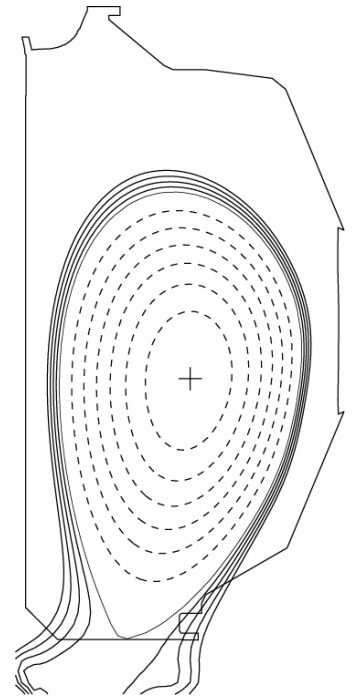
1000 ms



1500 ms



1700 ms

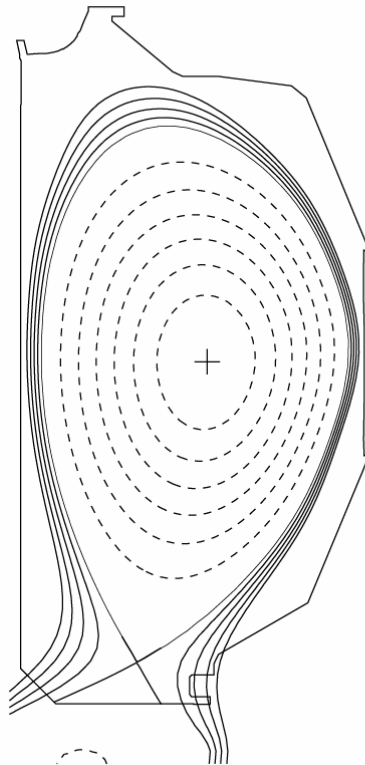


1725 ms

Equilibrium parameters

```

shot      114667
time      1700.00
chi**2    15.268
Rout(m)   1.695
Zout(m)   -0.160
a(m)      0.598
elong    1.745
ultri     0.186
ltri      0.377
indent    0.000
V (m**3)  18.708
A (m**2)  1.796
W (MJ)    0.346
beta I (%) 0.701
beta P    0.241
beta N    0.600
ln        1.157
Li        1.154
error(e-4) 27.309
q1        7.270
q95       3.295
dsep(m)   0.061
Rm(m)     1.742
Zm(m)     -0.034
Rc(m)     1.697
Zc(m)     -0.045
betaPd    0.158
betaId    0.481
Wdia(MJ)  0.228
lomeas(MA) 1.478
BT(O)(T)  2.103
lpit(MA)  1.469
Rmidin(m) 1.097
Rmidout(m) 2.291
gapin(m)  0.081
gapout(m) 0.061
gaptop(m) 0.419
gapbot(m) 0.151
Zts(m)    0.736
Rvsin(m)  -1.146
Zvsin(m)  -1.359
Rvsout(m) 1.563
Zvsout(m) -1.366
Rsep1(m)  1.469
Rsep1(m)  -1.204
Rsep2(m)  -0.990
Zsep2(m)  -0.990
psib(Vs/R) -0.022
elongm    1.358
qm         0.941
nev1(e19) 2.850
nev2(e19) 2.835
nev3(e19) 2.835
ner0(e19) 3.033
n/nc      -0.708
dRsep     -0.400
qmin      0.941
rhoqmin   0.000
    
```

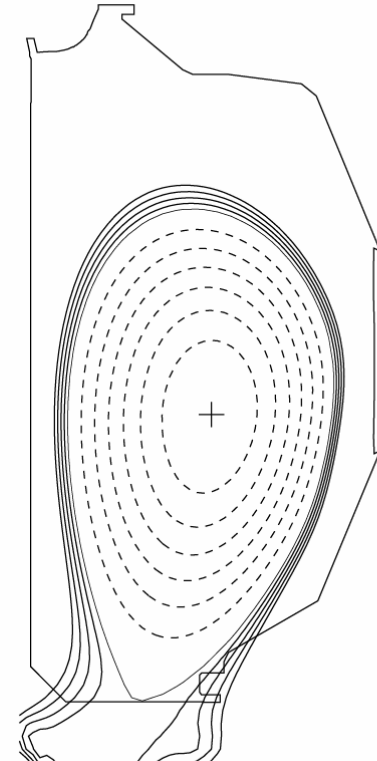


114667 1700.00

1700 ms

```

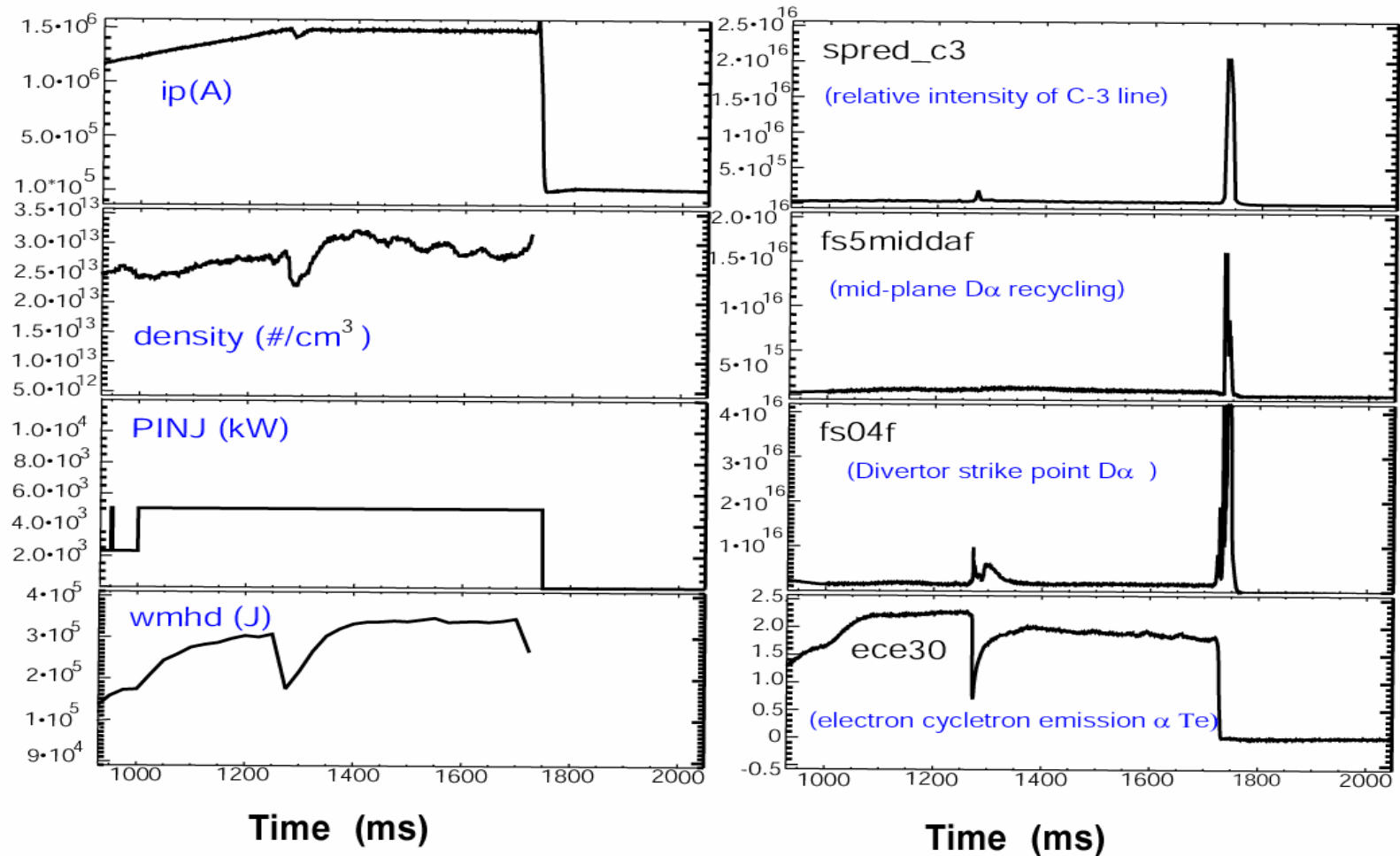
shot      114667
time      1725.00
chi**2    105.802
Rout(m)   1.678
Zout(m)   -0.407
a(m)      0.518
elong     1.853
ultri     0.080
ltri      0.490
indent    0.000
V (m**3)  15.937
A (m**2)  1.471
W (MJ)    0.266
beta I (%) 0.650
beta P    0.190
beta N    0.486
ln        1.338
Li        0.853
error(e-4) 0.014
q1        4.903
q95       2.884
dsep(m)   -0.000
Rm(m)     1.720
Zm(m)     -0.248
Rc(m)     1.666
Zc(m)     -0.273
betaPd    0.056
betaId    0.192
Wdia(MJ)  0.079
lomeas(MA) 1.483
BT(O)(T)  2.101
lpit(MA)  1.471
Rmidin(m) 1.182
Rmidout(m) 2.185
gapin(m)  0.144
gapout(m) 0.031
gaptop(m) 0.740
gapbot(m) 0.000
Zts(m)    0.438
Rvsin(m)  0.000
Zvsin(m)  0.000
Rvsout(m) 0.000
Zvsout(m) 0.000
Rsep1(m)  1.404
Rsep1(m)  -1.383
Rsep2(m)  -1.225
Zsep2(m)  -1.106
psib(Vs/R) 0.017
elongm    1.623
qm         1.429
nev1(e19) 3.392
nev2(e19) 3.392
nev3(e19) 3.803
ner0(e19) 3.826
n/nc      -0.882
dRsep     0.400
qmin      1.429
rhoqmin   0.000
    
```



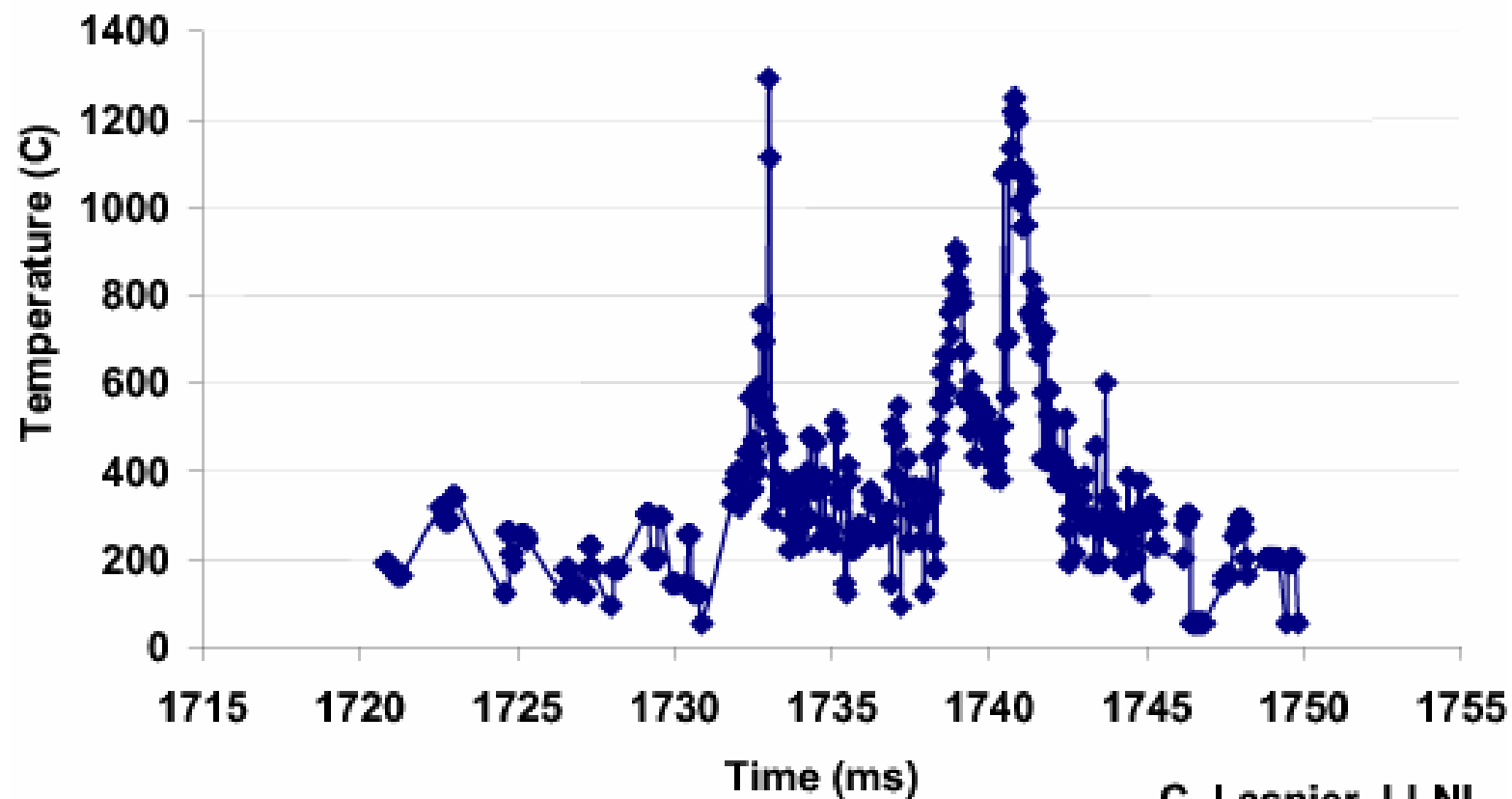
114667 1725.00

1725 ms

Selected plasma parameters (disruption shot 114667)



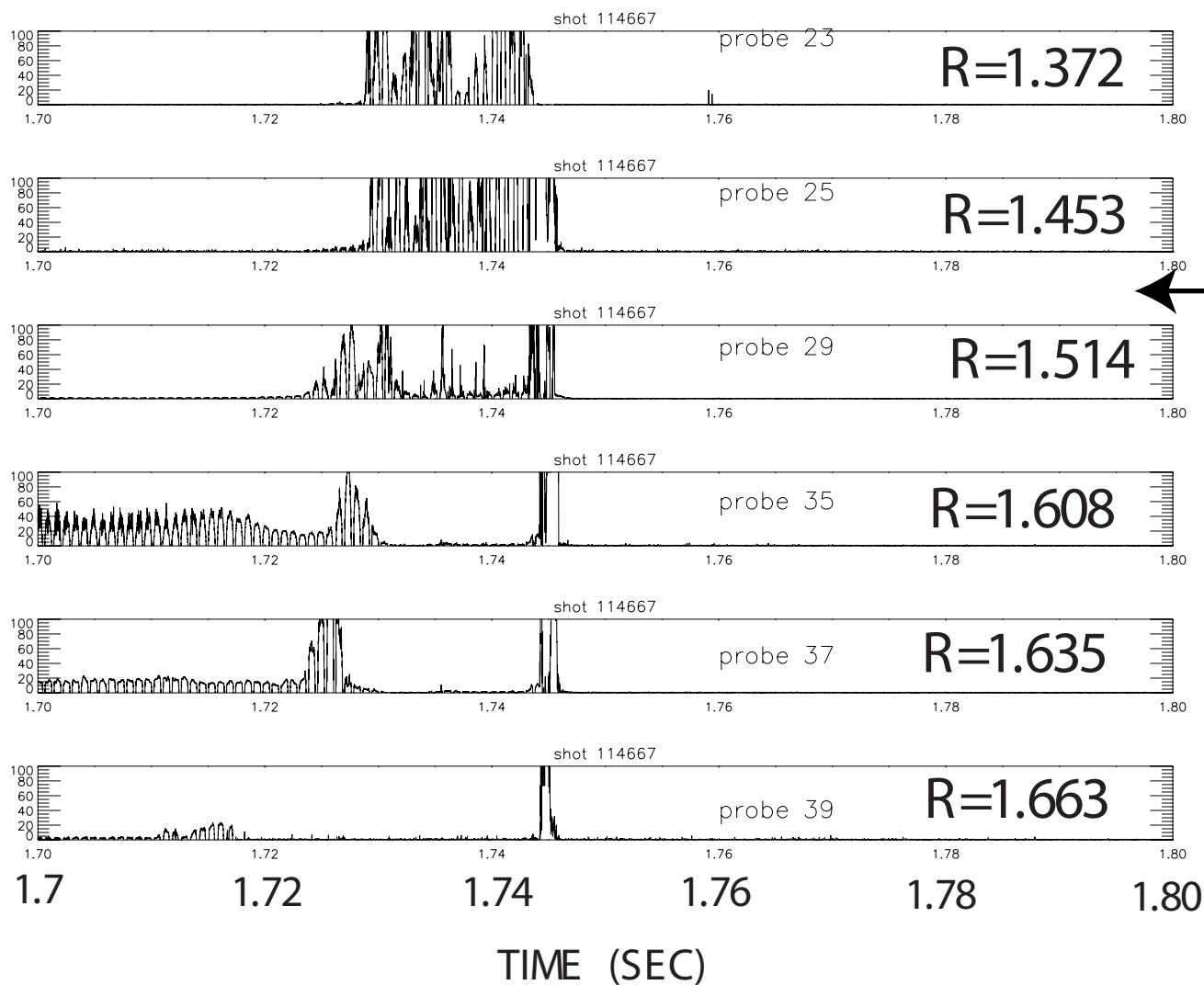
Surface temperature response to disruption (#114667)



FAST TARGET PLATE MEASUREMENTS SHOW DISRUPTION CONDITIONS

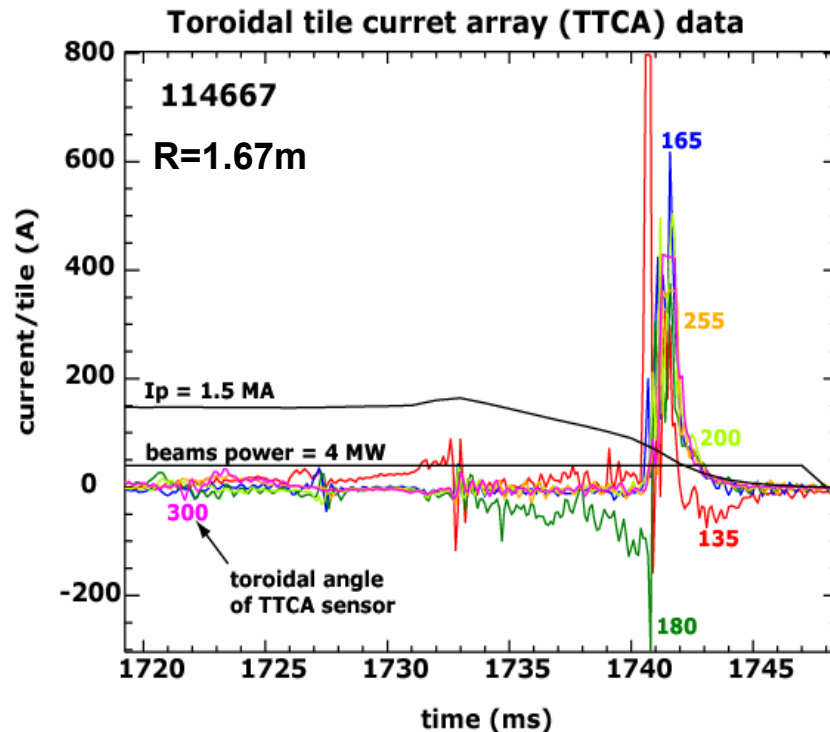
PERPENDICULAR PARTICLE FLUX TO PLATE (A/CM^2)

{Scale: 0-100}



← DICES

SOL current distribution in the toroidal tiles from DIII-D disruption # 114667 (array located 1 tile out from DiMES)



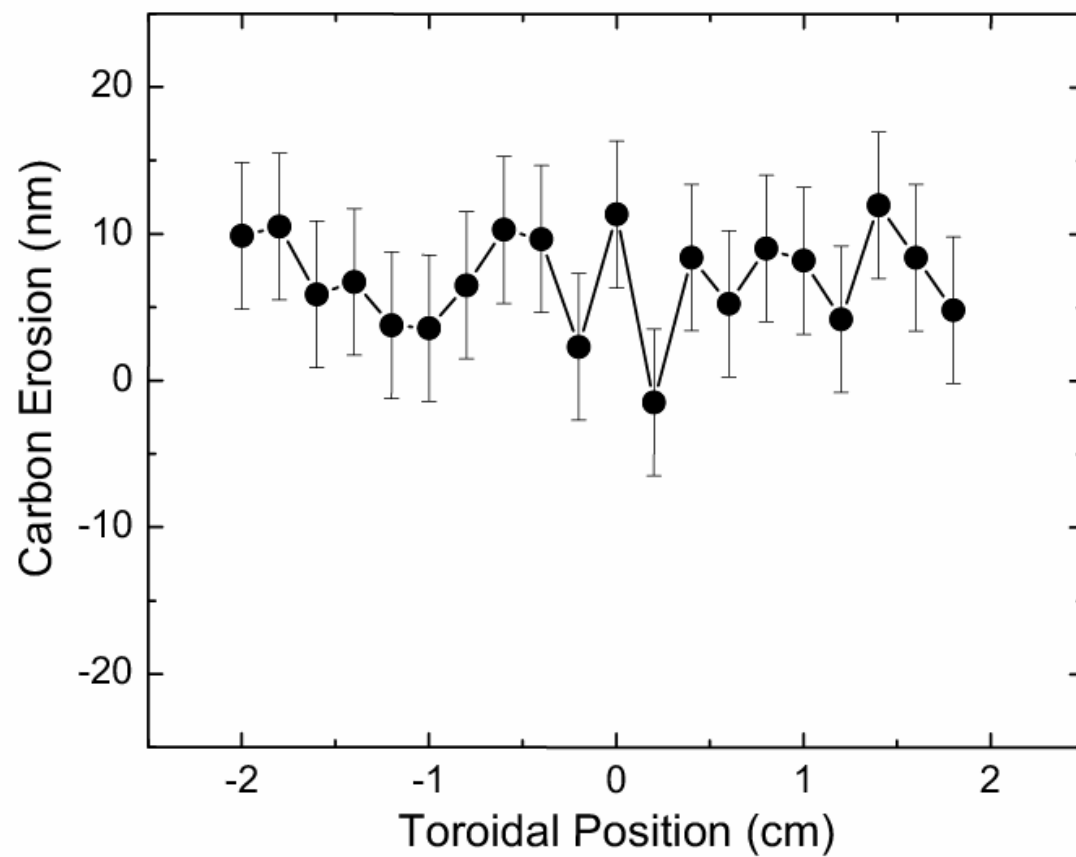
- The new high resolution DiMES tile current array will be used to study:
 - ELMs during stochastic boundary ELM control experiments
 - ITER ELMs simulations during DIII-D disruptions, and
 - The detailed structure of the SOL currents across the separatrix for MHD stability modeling.

- Large toroidal asymmetries are observed in the SOL currents during ELMs and disruptions in DIII-D.
- Similar currents can have strong impacts to the structural loading of ITER divertor components and the migration of evaporated or melted materials.
- These tile currents should be included in the ELMs and disruption modeling.



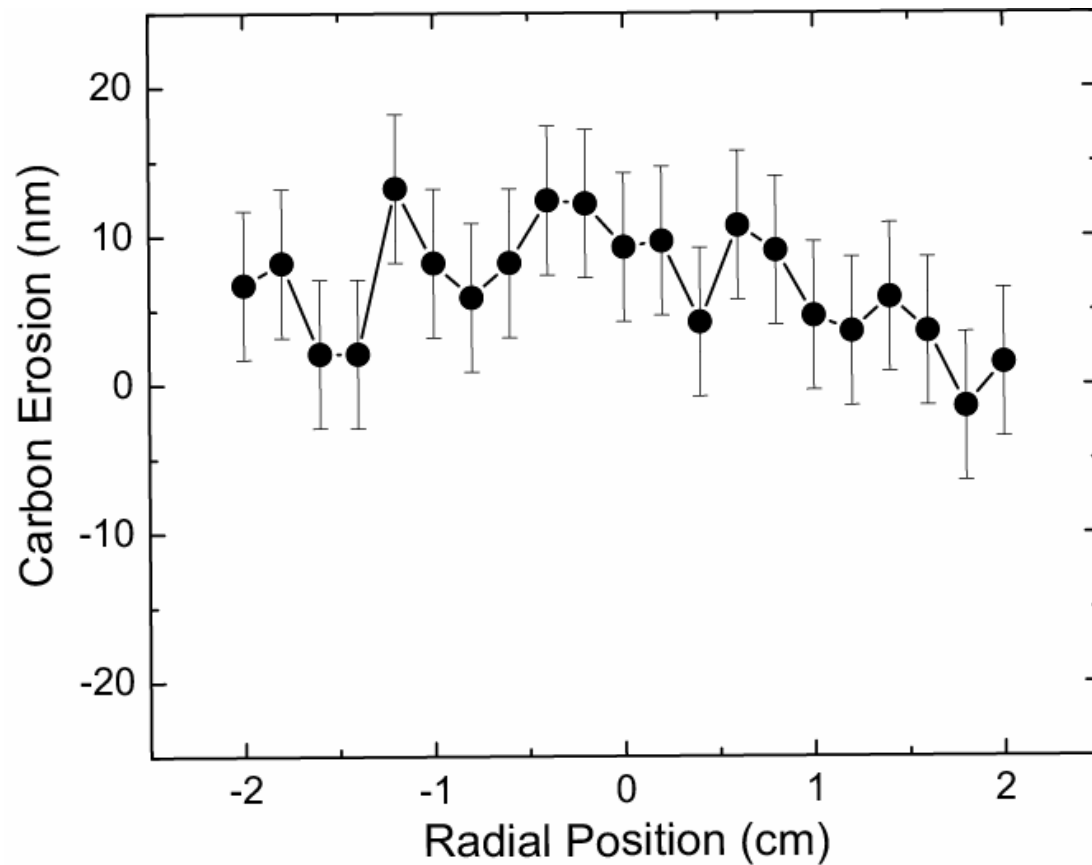
T. Evans

DiMES sample101 after exposure to VDE disruption 114667
(Toroidal position)



W. Wampler SNL

**DiMES sample 101 after exposure to VDE disruption 114667
(Radial position)**



W. Wampler SNL

ITER ELM simulation observations

- Fast diagnostics are needed to quantify ELMs and disruptions physics. Optical measurements are usually too slow to distinguish details.
- **Temperature, particle flux, tile current variations and distributions have been recorded for shot # 114667**
- Significant toroidal, radial and temporal variations are shown.
- **Similar variations have been observed for both ELMs and disruptions.**
- These variations should be included in the ELMs and disruptions modeling codes.
- **Further analysis on available data on shot #114667 will continue.**
- Consistent yet very low erosion of graphite surface has been measured on disruption shot #114667 with different toroidal and radial distributions.
- **We should continue to perform well planned experiments to investigate different ways to perform experiments using DiMES and/or in DIII-D to provide experimental data to bench mark modeling efforts. (e.g. ELMing discharges on DiMES surface with low melting point metal like Li or Al, disruption discharge on a DiMES multiple materials sample...)**

CoDep Tracer Experiment on DIII-D

Question: Where does chemically sputtered carbon from the main chamber wall redeposit?

Why are we interested: Chemical sputtering is an important source of carbon in the DIII-D main chamber

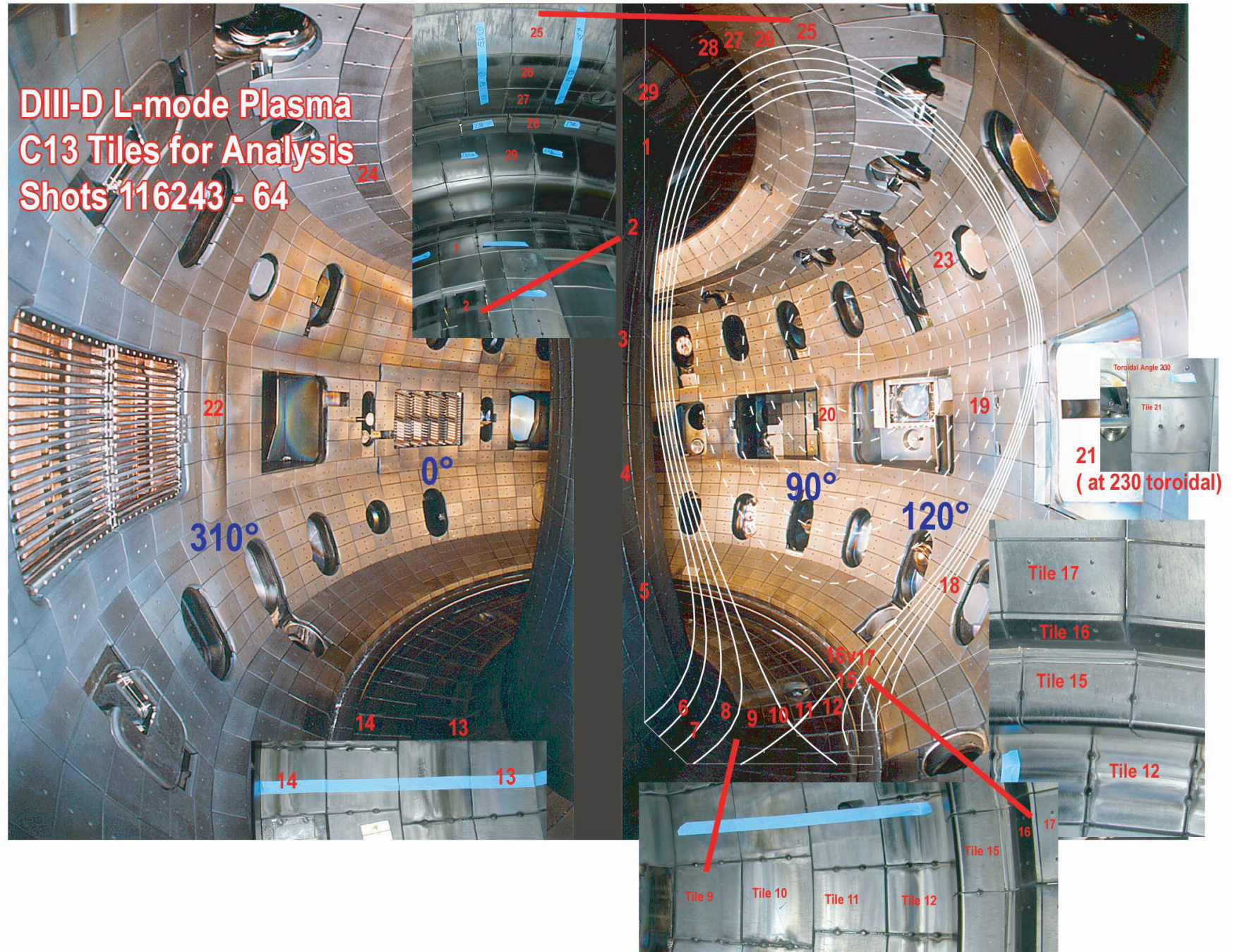
Redeposition of C leads to Codeposition of hydrogen isotopes. Location of codeposition of tritium is a key issue for ITER

Experiment to address this question:

- Inject $^{13}\text{CH}_4$ into main chamber on last day of operations before a major vent
- Remove a poloidally distributed set of tiles and analyse surface for ^{13}C content.
- Inject methane under upper baffle to provide a toroidally distributed source
- Use highly repeatable L-mode plasmas for 1) injection of sufficient ^{13}C for detection above the background and 2) use previous detailed diagnostic characterization so that fluid models can be applied to analysis.

Success: 20 identical (as best as we can tell) discharges with $^{13}\text{CH}_4$ injection.
29 tiles removed and delivered to SNL-NM for Ion Beam Analysis.

Location of the 29 Tiles Removed from DIII-D and Photos of Tiles In-situ



DISTINGUISHING PHYSICAL AND CHEMICAL SPUTTERING FROM ANALYSIS OF C I LINESHAPES

by
N.H. Brooks
in collaboration with
R.C. Isler

Presented at
DIII-D Science Meeting

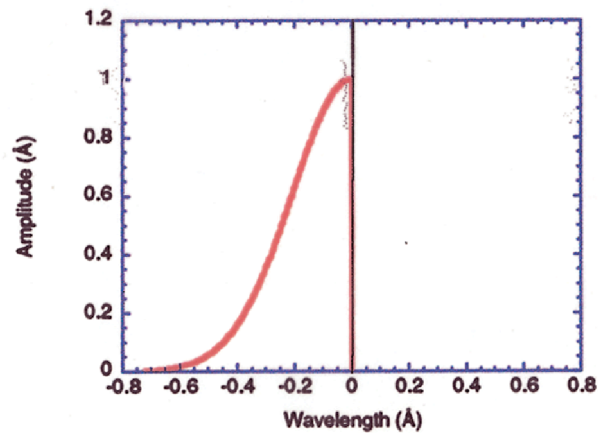
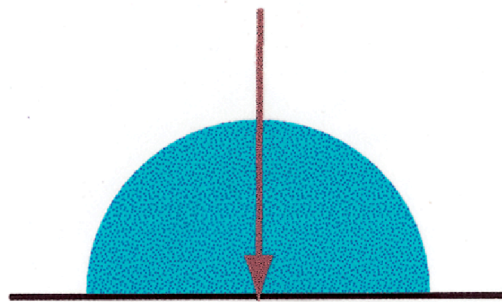
September 6, 2002



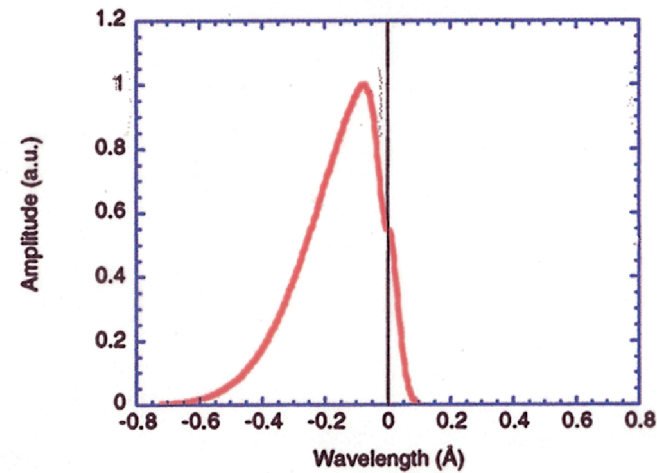
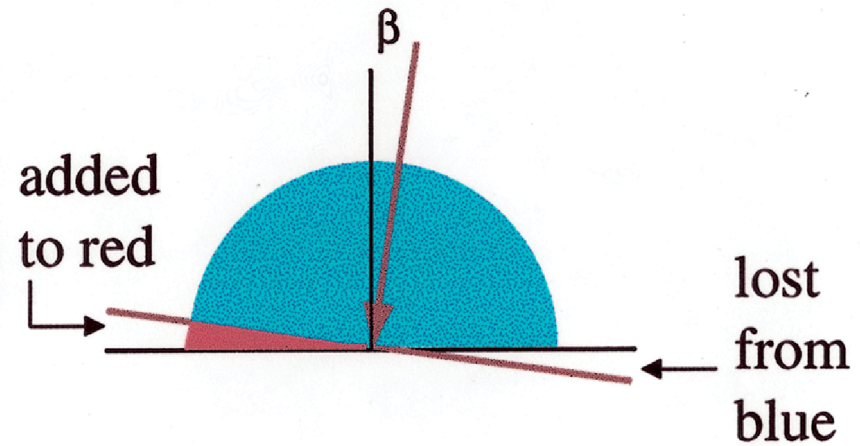
4.

Non-isotropic distributions Maxwellian hemisphere

Normal View

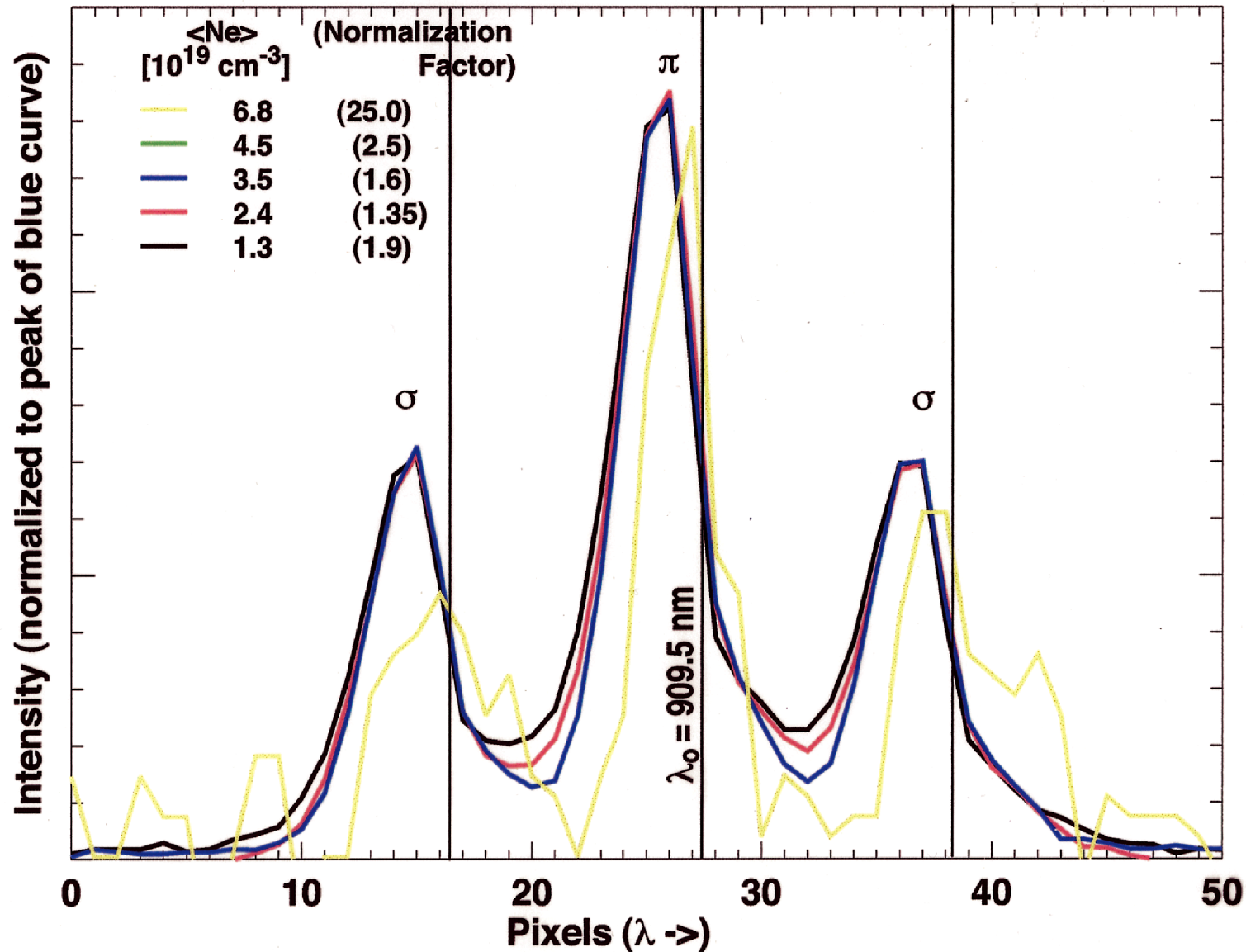


Angled View



PHYSICAL SPUTTERING OF GRAPHITE BY HELIUM

- Centers of the C I zeeman components shift to shorter wavelength as ion impact energy rises
- Line profile broadens asymmetrically on blue side

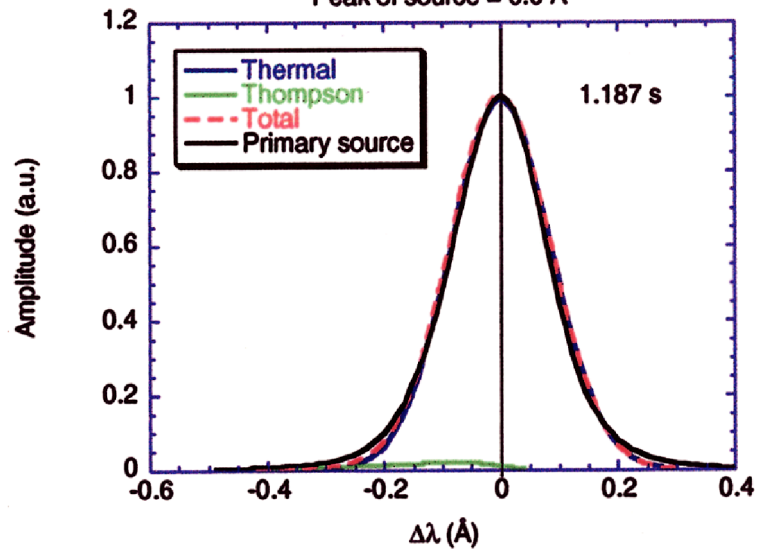


5.

#105500 - Track 6 - Frame 10

$E_{\text{imp}} = 140 \text{ eV}$, $T_e = 1.0 \text{ eV}$

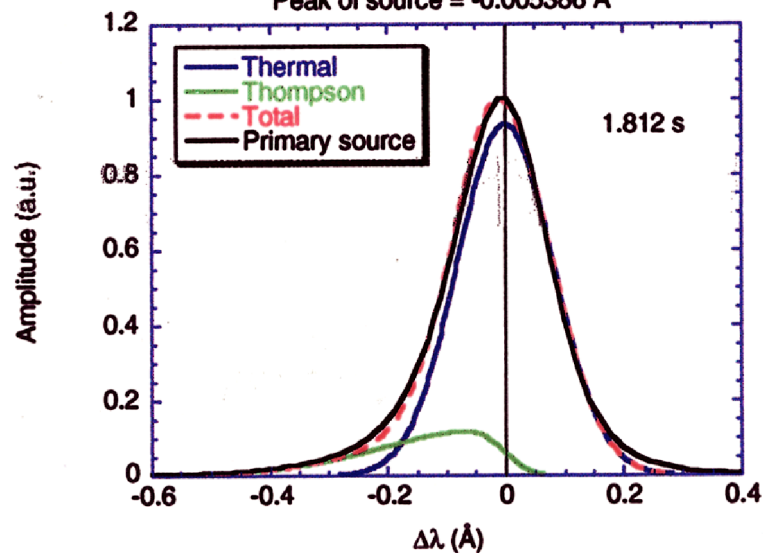
Peak of source = 0.0 Å



#105500 - Track 6 - Frame 15

$E_{\text{imp}} = 140 \text{ eV}$, $T_e = 0.9 \text{ eV}$

Peak of source = -0.005386 Å



Profile modeling for #105500, V6

#105500 - Track 6 - Frame 20

$E_{\text{imp}} = 140 \text{ eV}$, $T_e = 1.0 \text{ eV}$

Peak of source = -0.01131 Å

